Sustainability of Land Use in Puerto Rico

Center for Sustainable Development Studies

School of Environmental Affairs

UNIVERSIDAD METROPOLITANA

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Aim of our Project

Sustainability of Land Use in Puerto Rico

The original and primary aim of our project is to develop a model using geographic information systems (GIS) with a land use sustainability index to provide a scientifically reliable tool to measure and monitor the impacts of the progression of the urban built environment on the quality and availability of land, ecosystems, and water in Puerto Rico for long term sustainability.

Urban Sprawl:
Suburban expansion in the San Juan Metropolitan Area

This research is funded by U.S. EPA - Science To Achieve Results (STAR) Program Grant #

How does your work meet the needs of environmental decision making for sustainability?

Expected contribution:

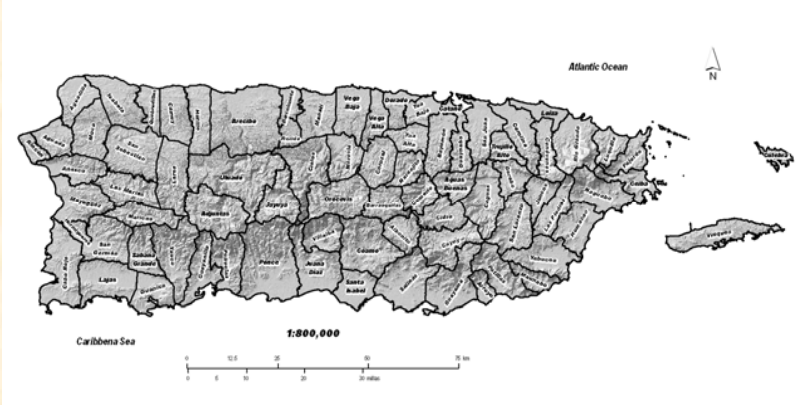
- Our work will provide an easy-to-use index model with indicators that are fed with accessible and reliable information to evaluate municipal land use plans towards sustainability.
- The model will also provide a sustainable status of municipal land use activities for public policy decisions.
- Four municipalities are being used as case studies and the outcomes will be transferable to the other municipalities.
- The model could be transferable to other islands.

This research is funded by U.S. EPA - Science To Achieve Results (STAR) Program Grant # SD9822870

Sustainability challenges for land use decision making in Puerto Rico:

Why is the municipality (equivalent to township) the territorial unit for the project?

- There are 78 municipalities in Puerto Rico's relatively small surface area (8,870 km²) and the local Autonomous Municipality Act requires them to have a land use plan although there is no an island-wide land use sustainable framework to guide them at present (an island-wide land use plan is still in process).



- Municipalities are required to revise their land use plans every 8 years.

Also:

- Puerto Rico is an island with a high population density (429 inhabitants per square kilometers), topographical limitations, and a serious combination of natural hazards.

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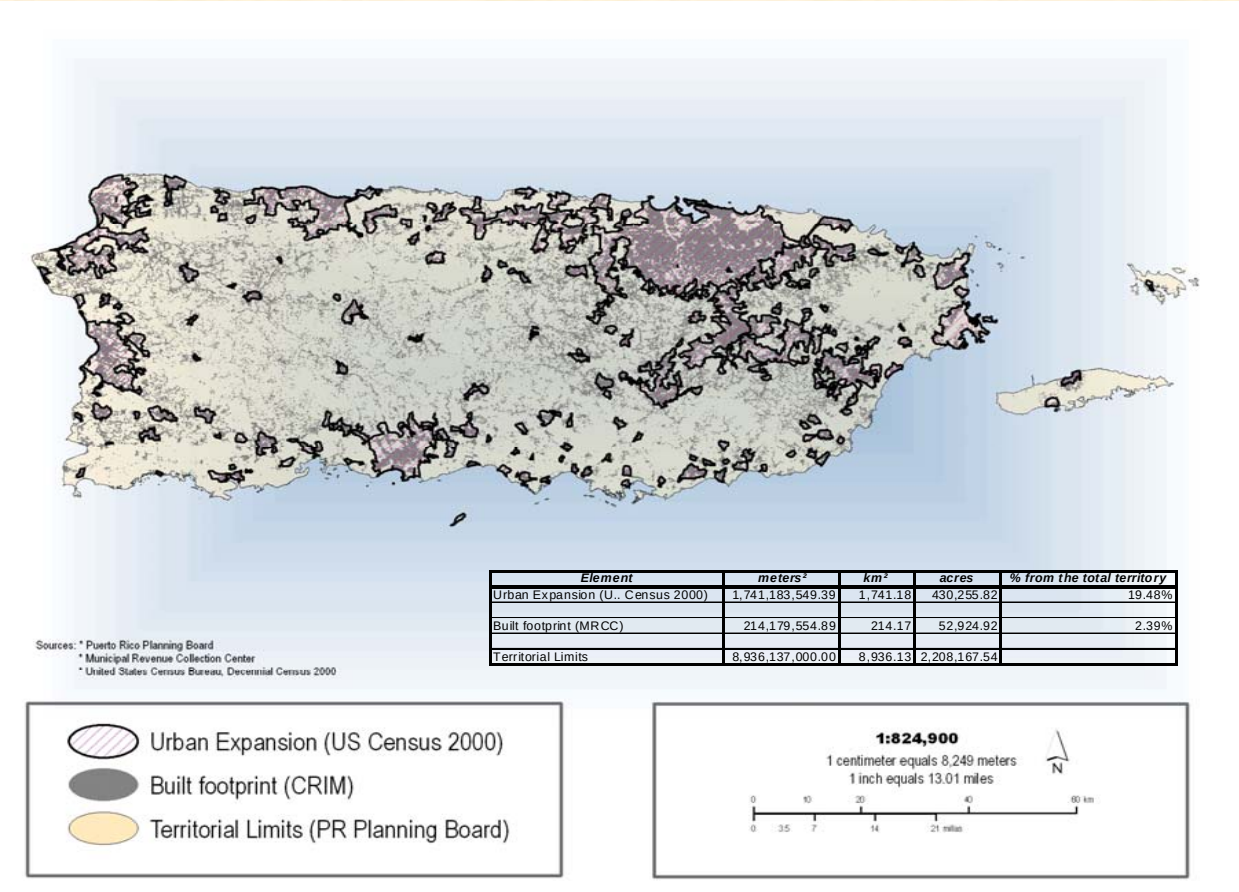
Sustainability challenges for land use decision making in Puerto Rico



Element	meters²	km²	acres	% from the total territory
Urban Expansion (U.. Census 2000)	1,741,183,549.39	1,741.18	430,255.82	19.48%
Built footprint (MRCC)	214,179,554.89	214.17	52,924.92	2.39%
Territorial Limits	8,936,137,000.00	8,936.13	2,208,167.54	

22% of the island is covered by urban expansion as defined by the US Census Bureau 2000, plus built-up areas as delimitated by the CRIM (Municipal Revenue Collection Center). The impact of low density development, based on the scattered patterns of the built up areas outside the official urban areas defined by the U.S. Census, is significant and demonstrates the sustainability challenge for land use in Puerto Rico.

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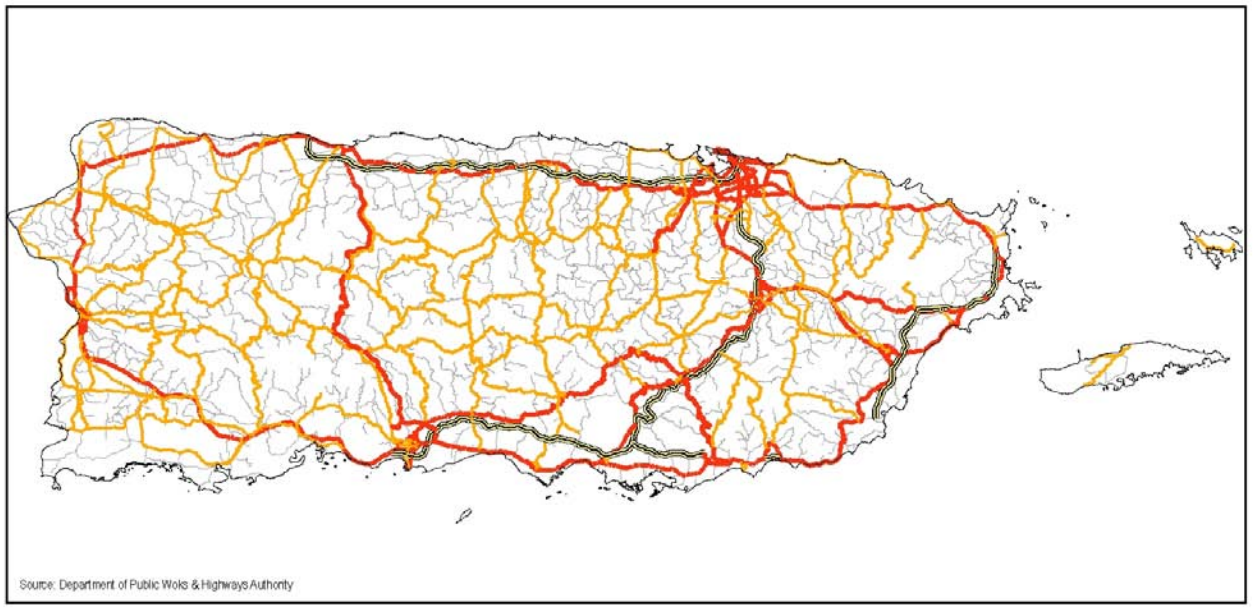
Sustainability challenges for land use decision making in Puerto Rico



Puerto Rico Road System = **26,186.30 Km**

Contributes to low-density development widespread across much of the island outward from the urban centers in linear features following the extensive rural-road network and some of the highways and routes.

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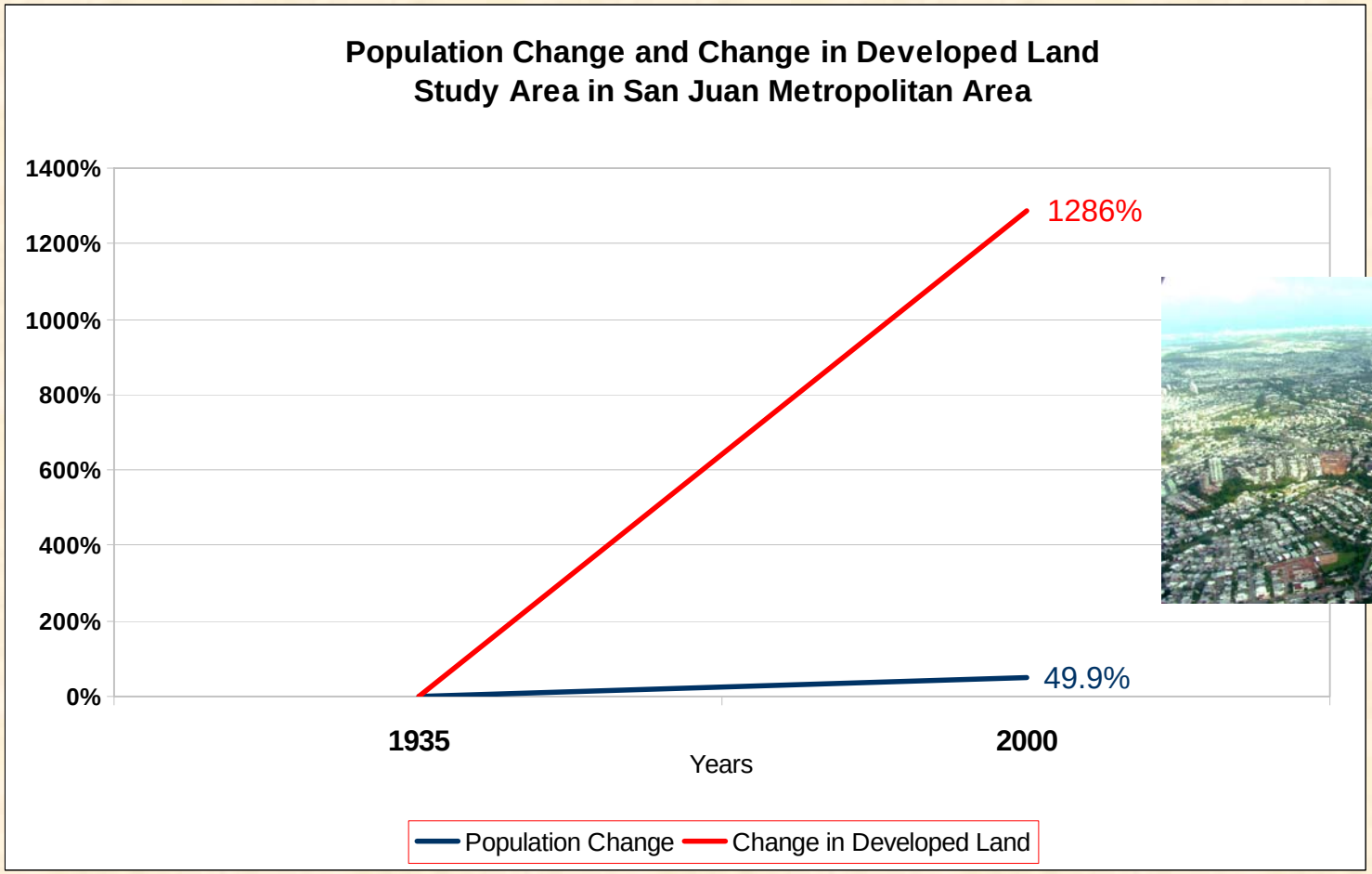
Sustainability challenges for land use decision making in Puerto Rico



Study area municipalities: Bayamón, Carolina, Cataño, Guaynabo, San Juan, Toa Alta and Trujillo Alto. Updated results from Universidad Metropolitana (2001), *Puerto Rico's Road to Smart Growth.*

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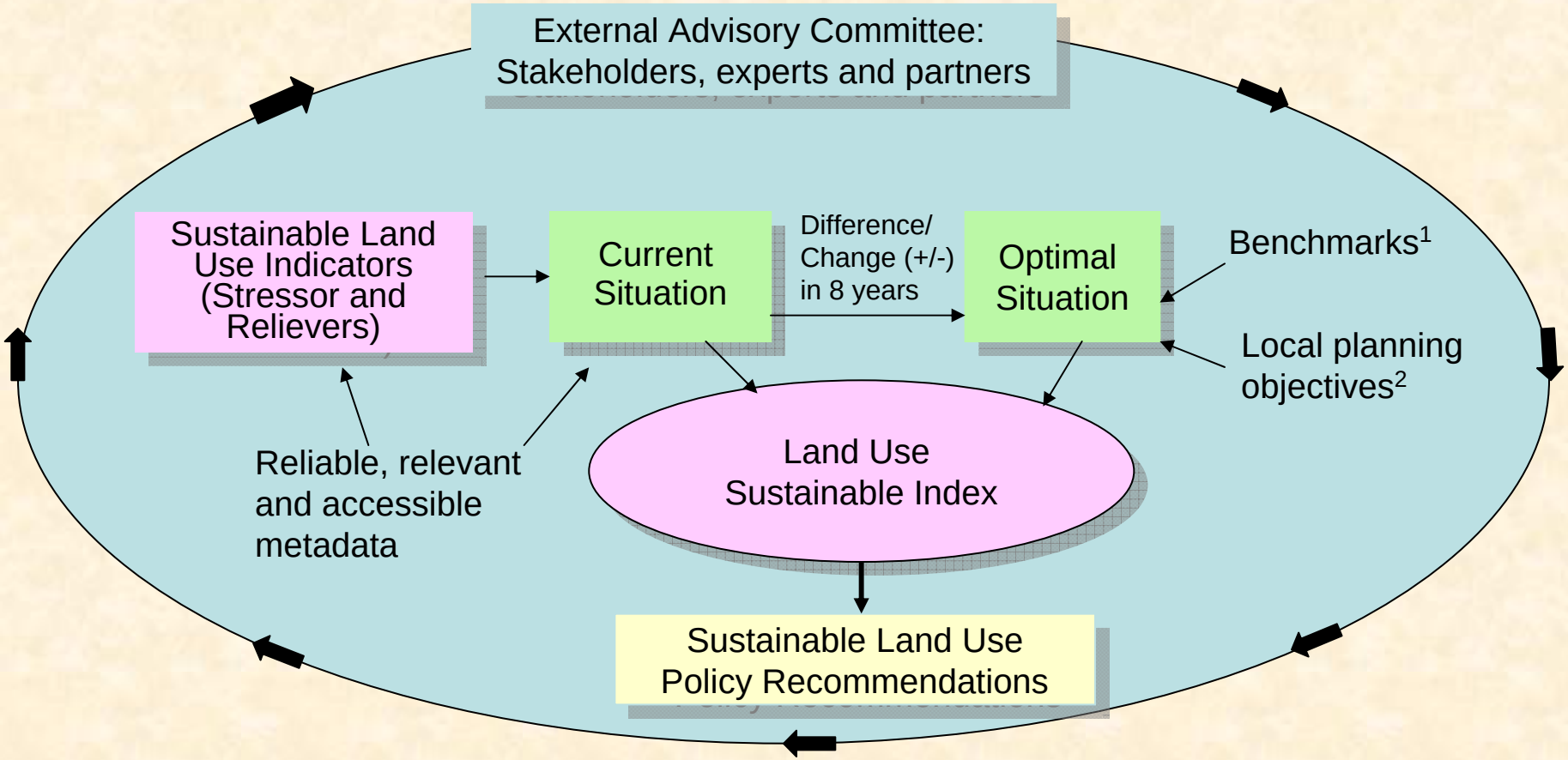
Schematic overview of the project



1. **A locally accepted public policy goal, an internationally agreed goal or a scientifically accepted threshold.**
2. **When there is no benchmark, we use planning goals for Puerto Rico based on local stakeholder and expert opinions.**

Schematic overview of the project

Four primary components:

- Describe the current land use situation using selected indicators as stressors and relievers (an evaluation of how close or far is the municipality from sustainability of land use) based on available and reliable information.
- Establish a base optimal land use based on benchmarks or planning objectives for the selected indicators that will help measure positive or negative change through time.
- Provide a land use sustainable index to measure status and progress.
- Receive constant feedback and collaboration for the decision making process by stakeholders, experts and partners (External Advisory Committee).

In the last 25 years, 45% of built-up areas (mostly suburban low density growth) occurred in valuable agricultural lands.

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Selection of indicators

1. Maturity (reliable metadata based on the best available information)
2. Relevant and functional for land use planning at the municipal level
3. Adaptable to different scenarios (78 municipalities)
4. Must be able to evaluate current situation and future tendencies
5. Have quantitative and qualitative value

A tentative group of indicators was selected by the Project Team with the input of the Advisory Committee composed mostly of local and federal government agencies and municipal officials (informed stakeholders and experts).

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Tentative Selected Indicators (23)

Environmental
1. Percentage of houses without sewage connection from total housing units.
2.Development pressure in Rustic Land (change in housing density)
3. Percentage of officially protected land by federal, state and municipal governments.
4. Population living in urban areas at 15 minutes walking distance from parks and natural public open spaces.
5. Total solid waste generation per person per day.
6. Percentage of recycled solid non-hazardous waste from total annual waste generation.
7. CO^2 generation per passenger cars registered per year.
8. Percentage of houses in coastal hazard areas from total housing units
9. Water consumption per house per day
10. Energy consumption per house per day

Institutional
22. Approved land use plan by the Puerto Rico Planning Board
23. Fiscal Fragility Index

Socio-economics
11. Percentage of highly valuable agricultural lands
12. Percentage of active agricultural lands.
13. Percentage of residents that work in the same municipality.
14. Repopulation of urban areas (change in population density)
15. Total number of people living in zone prone areas.
16. Percentage of families that receive public assistance.
17. Socio-economic Index
Infrastructure
18. Percentage of change in the use by residents of public transportation to work.
19. Percentage of wards served by at least one public transportation service route to urban center.
20. Percentage of Public road's footprint from total municipal land.
21. Total wards with accessibility deficiencies to potable water.

The Project Team is preparing a Methodology Report for the indicators with information about the metadata.

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Tentative Selected Indicators (23)

Methodology Report will include for each indicator:

1. Measurement (what is being measured, description of the indicator)
2. Rationale/context for sustainability of land use
3. Recommended benchmark or planning objective and why
4. Calculation
5. Units
6. Data collection methods and sources
7. Data collection year
8. Data collection frequency or frequency of measurement
9. Temporal and spatial format / reporting format
10. Limitations

Tentative Selected Indicators
Stressors

	Municipal Indicators	PONCE	CAGUAS	BARCELONETA	CAROLINA	Planning Objective or Benchmark for the Indicator	Benchmark for the Index	Suggested Weighing Scale 1 to 10
1	Total number of people living in flood prone zones.	2,699	3,337	1,023	816	0	0	**1.00**
2	Total wards with accessibility deficiencies to potable water.	3	2	1	2	-60%	1.00	**0.90**
3	Percentage of houses without sewage connection from total housing units.	34.0%	29.8%	46.1%	24.9%	-20%	20%	**0.80**
4	Solid waste generation per person per day (pounds).	4.2	5.9	7.5	3.2	3.4	3.4	**1.00**
5	CO_2 generation per passenger cars registered per year (tons).	584,900	514,471	84,192	661,358	-7%	500,000	**1.00**
6	Percentage of houses in coastal hazard areas from total housing units.	2%	N/A	6%	7%	-5%	5%	**0.80**
7	Precentage of pulblic road's footprint from total municipal land.	9%	11%	9%	13%	0	13%	**0.80**
8	Fiscal Fragility Index	13.53	-9.51	0.22	0.06	0	20.00	**2.00**
9	Water consumption per house per day (gallons).	166	164	164	172	-25%	124	**1.00**
10	Energy consumption per house per day (kilowats).	5,754	6,222	4,049	7,508	-7%	5,500	**0.60**
11	Development pressure in Rustic Land (housing density).	54	133	91	98	0	100	**2.00**
12	Socioeconomic Index	95.83	109.15	82.78	132.55	100	100	**2.50**
13	Families that receive public assistance.	24%	16%	25%	11%	-10%	10%	**4.00**

With suggested objectives / benchmarks and weight.

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Tentative Selected Indicators
Relievers

	Municipal Indicators	PONCE	CAGUAS	BARCELONETA	CAROLINA	Planning Objective or Benchmark for the Indicator	Benchmark for the Index	Suggested Weighing Scale 1 to 10
14	Percentage of officially protected land by federal, state and municipal governments.	33%	4%	53%	22%	30%	30%	**0.80**
15	Percentage of change in the use of public transportation for work.	-1.0%	-2.0%	0.0%	-2.0%	+5.0%	5%	**0.60**
16	Repopulation in urban areas (change in population density).	1,598	2,189	809	3,299	+10%	2,200	**2.30**
17	Approved land use plan by the PR Planning Board	1	1	1	1	1	1	**1.70**
18	Percentage of highly valuable agricultural lands.	14%	16%	55%	14%	0	variable	**1.70**
19	Percentage of active agricultural lands.	23%	15%	18%	18%	0	variable	**1.00**
20	Percentage of residents that work in the municipality.	86.0%	56.0%	56.0%	42.0%	60%	60%	**2.00**
21	Wards served by at least one public transportation service route to urban centers.		In process of development					**3.20**
22	Population living in the urban areas 15 minutes walking distance from parks and natural public open spaces.							**2.30**
23	Percentage of recycled solid non -hazardous waste from total annual waste generation.	2.9%	9%	1.5%	1.1%	35%	35%	**6.00**

With suggested objectives / benchmarks and weight.

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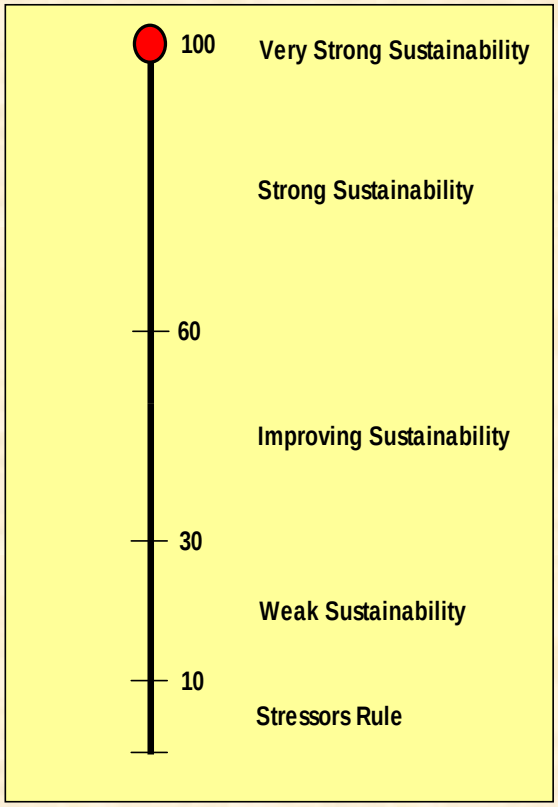
ISLA Composite Index Model

$$ISLA = \sqrt{\frac{RI}{SI} \times 100}$$

Relievers Index (RI) and a Stressors Index (SI)

ISLA ranges in value from 1 to 100, as do RI and SI individually. RI is calculated as a weighted geometric mean of individual reliever indicators, each of which has been divided first by a benchmark value. SI is calculated in the same manner, but using stressor indicators. In ISLA, the value 10 separates sustainability from non-sustainability. At 10, stressors and relievers cancel each other. Below 10, stressors outweigh relievers. For values higher than 10, relievers outweigh stressors.



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Preliminary results:

	Ponce	Caguas	Barceloneta	Carolina
ISLA Composite Index	**7.645**	**9.032**	**8.917**	**9.125**

When the ISLA composite index model was run for the first time, all 4 municipalities used as case studies came out very low in sustainability (lower than 10), a mirror of the unsustainable reality of land use trends in PR.

At this phase of the project, the research team is revaluating and validating with the Advisory Committee and local experts the parameters used in the model (benchmarks/planning objectives).

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How have you responded to feedback from stakeholders?

Project integrates key public stakeholders through an Advisory Committee:

- **13 municipalities (4 as case study: Carolina, Ponce, Barceloneta, Caguas)**
- **4 local government agencies (PRDNER, PRPB, PREQB, PRDA)**
- **2 federal agencies (USFS, USDA)**

Also included in the Committee:

- **Puerto Rico Planning Society**
- **Estudios Técnicos, Inc. and Advantage, Inc., 2 locally economic and planning consulting firms.**

Municipalities in the Advisory Committee

Discussion meetings every two to three months:

Stakeholders provide feedback and present their evaluations of the different stages of the project at the meetings.

The Project Team incorporates stakeholders feedback in the decision making process: selection of indicators, weight and benchmarks for each indicator, and possible planning objectives.

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Lessons Learned

- Stakeholders' participation from the beginning resulted in successful collaboration and interest on the results of the project for decision making.
- Land use planning goals are being discussed and evaluated with stakeholders as alternatives when there are no clear and agreed upon benchmark for the indicators.
- The municipality as a territorial unit poses difficulties in data collection and analysis when the scope and origin of the land use activity has a regional character.
- The modeling method had to consider dissimilar conditions across municipalities.
- In Puerto Rico, reliability and availability of some data is a major challenge.

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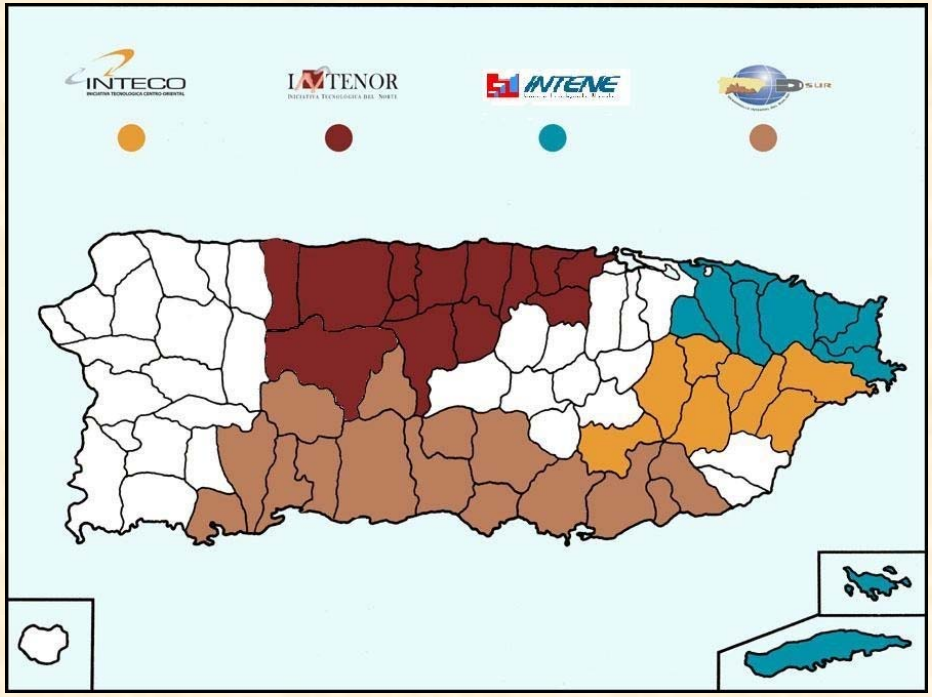
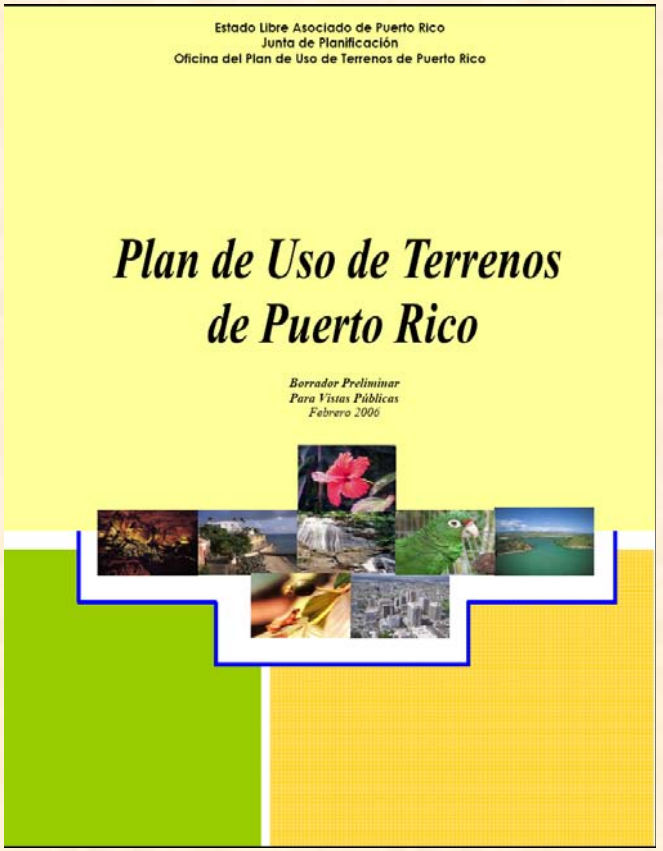
Update current/potential partners and potential clients who could learn from your project, and best collaboration stories.

The regional economic development operation INTENOR (North Region) composed of 15 municipalities, 3 universities (including ours) and several private organizations, has a Land Use Commission to establish a cohesive regional land use plan. Our composite index model could be used for policies and decision making. The University is also assisting in two other similar regional initiatives: INTECO (Central West Region) and INTENE (Northeast Region).



Update current/potential partners and potential clients who could learn from your project, and best collaboration stories.

The Puerto Rico Land Use Plan Act (2004) - enacted to develop an island-wide land use plan – also requires the development of a set of indicators to evaluate land use policies. This initiative is still not finalized and had been halted by the government due to pressure from different economic sectors and for political reasons. Nevertheless, agencies involved in developing the plan are members of the External Advisory Board and are awaiting the final results of our project.



Ways in which CNS funding and program have helped in enabling the University to be in involved with other collaborative efforts or spin-off efforts?

- **Universidad Metropolitana (UMET) has been invited to collaborate in the development of island-wide environmental indicators with the Puerto Rico Environmental Quality Board.**
- **UMET has also been invited to advise the regional initiatives INTENOR, INTECO, and INTENE.**
- **The Project Team was invited to present at the Puerto Rico Social Forum at the University of Puerto Rico (November 19, 2006).**
- **The project enhances ongoing education-related initiatives at UMET, especially the Puerto Rico version of ICMA and EPA's educational publication *Getting to Smart Growth: 100 Policies for Implementation.***
- **UMET has also been invited to participate in TV and radio programs.**

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Where do you foresee this work going in the future?

- **Objective tool to evaluate performance for sustainability:** **Development of Puerto Rico's State of Land Use for Sustainability Report where municipalities will be ranked every four/eight years according to land use "eco-efficiency"**

- **Initiative to spearhead public policy:** **Use of the Report and the index for municipal ordinances and public policies (Example: The results of a previous EPA's sponsored project at UMET - *Puerto Rico' Road to Smart Growth* – helped enact three new Smart Growth and environmental-related acts. Specifically: Urban Center Revitalization Act, San Juan Ecological Corridor Act, and Puerto Rico Land Use Plan Act.**

- **Collaborative agreements:** **Support to municipalities for specific land use sustainability projects (educational, research and public policy related project).**

- **Further research based on lessons learned:** **Opportunities to fine tune some indicators due to lack of reliable metadata at the present moment. Includes the possibility to expand the indicators to a regional scale using watersheds or regional municipal economic initiatives as territorial planning units.**

Questions and Feedback Welcome

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